

WHAT IS CLAIMED IS:

1. A waveguide antenna apparatus comprising:
a rectangular waveguide having one end short-circuited by a terminating conductor and another end opened, said rectangular
5 waveguide including a grounding conductor and a ceiling conductor that are opposed to each other, and further including two side surface conductors that join said grounding conductor with said ceiling conductor and are opposed to each other; and
an antenna element having one end and another end, one end of
10 said antenna element being electrically connected with a position in said ceiling conductor in a vicinity of opened another end of said rectangular waveguide, another end of said antenna element being electrically connected with a feeding portion located in the grounding conductor,
wherein said ceiling conductor includes a removed portion on the
15 side of opened another end of said rectangular waveguide,
whereby an electromagnetic wave of a radio signal fed to the feeding portion is radiated from the removed portion of said ceiling conductor and opened another end of said rectangular waveguide.
2. The waveguide antenna apparatus as claimed in claim 1,
20 further comprising at least one matching conductor for adjusting an input impedance of said waveguide antenna apparatus, said matching conductor being electrically connected with said grounding conductor.
3. The waveguide antenna apparatus as claimed in claim 2,
wherein at least one of said matching conductors is electrically
25 connected with said antenna element.
4. The waveguide antenna apparatus as claimed in claim 2,

wherein at least one of said matching conductors is electrically connected with said ceiling conductor.

5 5. The waveguide antenna apparatus as claimed in claim 1, further comprising at least one directivity pattern controlling conductor for changing a directivity pattern of said waveguide antenna apparatus, said directivity pattern controlling conductor being electrically connected with said grounding conductor.

6. The waveguide antenna apparatus as claimed in claim 5, wherein said directivity pattern controlling conductor comprises:
10 a first conductor portion for controlling a directivity pattern on a plane substantially perpendicular to said grounding conductor, said first conductor portion being electrically connected with said grounding conductor and provided so as to be substantially perpendicular to said grounding conductor; and

15 a second conductor portion for controlling a directivity pattern on a plane substantially parallel to said grounding conductor, said second conductor portion being connected with said first conductor portion and provided so as to be substantially parallel to said grounding conductor.

20 7. The waveguide antenna apparatus as claimed in claim 1, wherein said two side surface conductors are formed so as to be further apart from each other at opened another end of said rectangular waveguide than at one end of said rectangular waveguide short-circuited by said terminating conductor.

25 8. The waveguide antenna apparatus as claimed in claim 1, wherein said two side surface conductors are formed so as to be closer to each other at opened another end of said rectangular waveguide

than at one end of said rectangular waveguide short-circuited by said terminating conductor.

9. The waveguide antenna apparatus as claimed in claim 1,
wherein said terminating conductor is formed so that a length in
5 an electromagnetic wave propagation direction of said rectangular
waveguide in an approximately center portion of said terminating
conductor in a widthwise direction of said rectangular waveguide is larger
than that at widthwise end portions of said terminating conductor
respectively connected with said two side surface conductors.

10 10. A waveguide antenna apparatus comprising:

a rectangular waveguide having one end and another end both of
which are short-circuited respectively by terminating conductors, said
rectangular waveguide including a grounding conductor and a ceiling
conductor that are opposed to each other, and further including two side
15 surface conductors that join said grounding conductor with said ceiling
conductor and are opposed to each other;

an antenna element having one end and another end, one end of
said antenna element being electrically connected with said ceiling
conductor, another end of said antenna element being electrically
20 connected with a feeding portion located in the grounding conductor; and

at least one slit formed in said ceiling conductor in the widthwise
direction of the rectangular waveguide, said slit being located in a position
of which a distance to one end of said rectangular waveguide is
substantially different from a distance to another end of said rectangular
25 waveguide,

whereby an electromagnetic wave of a radio signal fed to said

feeding portion is radiated from said slit.

11. The waveguide antenna apparatus as claimed in claim 10,
wherein said slit is formed in a position located between (a) a
connection point in said ceiling conductor that connects said ceiling
5 conductor with said antenna element, and (b) said terminating conductor.

12. The waveguide antenna apparatus as claimed in claim 10,
further comprising at least one matching conductor for adjusting an input
impedance of said waveguide antenna apparatus, said matching
conductor being electrically connected with said grounding conductor.

10 13. The waveguide antenna apparatus as claimed in claim 12,
wherein at least one of said matching conductors is electrically
connected with said antenna element.

14. The waveguide antenna apparatus as claimed in claim 12,
wherein at least one of said matching conductors is electrically
15 connected with said ceiling conductor.

15. A waveguide antenna apparatus comprising:
a rectangular waveguide having one end short-circuited by a
terminating conductor and another end opened, said rectangular
waveguide including a grounding conductor and a ceiling conductor that
20 are opposed to each other, and further including two side surface
conductors that join said grounding conductor with said ceiling conductor
and are opposed to each other;

an antenna element having one end and another end, one end of
said antenna element being electrically connected with a position in said
25 ceiling conductor in a vicinity of opened another end of said rectangular
waveguide, another end of said antenna element being electrically

connected with a feeding portion located in the grounding conductor; and
at least one slit formed in said ceiling conductor in the widthwise
direction of the rectangular waveguide,

wherein said ceiling conductor includes a first removed portion on
5 the side of opened another end of said rectangular waveguide, and

wherein said two side surface conductors includes a second
removed portion on the side of opened another end of said rectangular
waveguide,

whereby an electromagnetic wave of a radio signal fed to the
10 feeding portion is radiated from the first removed portion of said ceiling
conductor and opened another end of said rectangular waveguide.

16. The waveguide antenna apparatus as claimed in claim 15,
further comprising at least one matching conductor for adjusting an input
impedance of said waveguide antenna apparatus, said matching
15 conductor being electrically connected with said grounding conductor.

17. The waveguide antenna apparatus as claimed in claim 16,
wherein at least one of said matching conductors is electrically
connected with said antenna element.

18. The waveguide antenna apparatus as claimed in claim 16,
20 wherein at least one of said matching conductors is electrically
connected with said ceiling conductor.

19. The waveguide antenna apparatus as claimed in claim 15,
further comprising at least one directivity pattern controlling conductor
for changing a directivity pattern of said waveguide antenna apparatus,
25 said directivity pattern controlling conductor being electrically connected
with said grounding conductor.

20. The waveguide antenna apparatus as claimed in claim 19,
wherein said directivity pattern controlling conductor comprises:
a first conductor portion for controlling a directivity pattern on a
plane substantially perpendicular to said grounding conductor, said first
5 conductor portion being electrically connected with said grounding
conductor and provided so as to be substantially perpendicular to said
grounding conductor; and

a second conductor portion for controlling a directivity pattern on
a plane substantially parallel to said grounding conductor, said second
10 conductor portion being connected with said first conductor portion and
provided so as to be substantially parallel to said grounding conductor.

21. The waveguide antenna apparatus as claimed in claim 15,
wherein said two side surface conductors are formed so as to be
further apart from each other at opened another end of said rectangular
15 waveguide than at one end of said rectangular waveguide short-circuited
by said terminating conductor.

22. The waveguide antenna apparatus as claimed in claim 15,
wherein said two side surface conductors are formed so as to be
closer to each other at opened another end of said rectangular waveguide
20 than at one end of said rectangular waveguide short-circuited by said
terminating conductor.

23. The waveguide antenna apparatus as claimed in claim 15,
wherein said terminating conductor is formed so that a length in
an electromagnetic wave propagation direction of said rectangular
25 waveguide in an approximately center portion of said terminating
conductor in a widthwise direction of said rectangular waveguide is larger

than that at widthwise end portions of said terminating conductor respectively connected with said two side surface conductors.

24. The waveguide antenna apparatus as claimed in claim 1,
wherein at least one part of an internal space of said rectangular
5 waveguide is filled with a dielectric material.

25. The waveguide antenna apparatus as claimed in claim 24,
wherein said grounding conductor is formed by a conductor
pattern formed on a first surface of a dielectric substrate having first and
second surfaces that oppose to each other,
10 wherein said ceiling conductor is formed by a conductor pattern
formed on the second surface of said dielectric substrate, and
wherein said side surface conductors and said terminating
conductor are formed by a plurality of through hole conductors that are
obtained by filling said dielectric substrate with through holes formed in a
15 direction of thickness.

26. The waveguide antenna apparatus as claimed in claim 1,
wherein said terminating conductor is formed so that a length in
an electromagnetic wave propagation direction of said rectangular
waveguide is larger in an approximately center portion of said terminating
20 conductor in a direction of height of said rectangular waveguide than that
at end portions of said terminating conductor in the direction of height of
said rectangular waveguide that are connected with said grounding
conductor and said ceiling conductor.

27. The waveguide antenna apparatus as claimed in claim 1,
25 wherein said terminating conductor is formed so that a length in
an electromagnetic wave propagation direction of said rectangular

waveguide is made larger from said ceiling conductor toward said grounding conductor.

28. The waveguide antenna apparatus as claimed in claim 1,
wherein said waveguide antenna apparatus is covered with a
5 radome having a circular bottom surface.

29. An array antenna apparatus comprising two waveguide
antenna apparatuses,
wherein each of said waveguide antenna apparatuses comprises:
a rectangular waveguide having one end short-circuited by a
10 terminating conductor and another end opened, said rectangular
waveguide including a grounding conductor and a ceiling conductor that
are opposed to each other, and further including two side surface
conductors that join said grounding conductor with said ceiling conductor
and are opposed to each other; and

15 an antenna element having one end and another end, one end of
said antenna element being electrically connected with a position in said
ceiling conductor in a vicinity of opened another end of said rectangular
waveguide, another end of said antenna element being electrically
connected with a feeding portion located in the grounding conductor,

20 wherein said ceiling conductor includes a removed portion on the
side of opened another end of said ceiling conductor, whereby an
electromagnetic wave of a radio signal fed to the feeding portion is
radiated from the removed portion of said ceiling conductor and opened
another end of said rectangular waveguide, and

25 wherein said two waveguide antenna apparatuses are provided so
that respective opened another ends of the rectangular waveguides of said

waveguide antenna apparatuses are opposed to each other.

30. An array antenna apparatus comprising two waveguide antenna apparatuses,

wherein each of said waveguide antenna apparatuses comprises:

5 a rectangular waveguide having one end short-circuited by a terminating conductor and another end opened, said rectangular waveguide including a grounding conductor and a ceiling conductor that are opposed to each other, and further including two side surface conductors that join said grounding conductor with said ceiling conductor
10 and are opposed to each other; and

an antenna element having one end and another end, one end of said antenna element being electrically connected with a position in said ceiling conductor in a vicinity of opened another end of said rectangular waveguide, another end of said antenna element being electrically
15 connected with a feeding portion located in the grounding conductor,

wherein said ceiling conductor includes a removed portion on the side of opened another end of said ceiling conductor, whereby an electromagnetic wave of a radio signal fed to the feeding portion is radiated from the removed portion of said ceiling conductor and opened
20 another end of said rectangular waveguide, and

wherein said two waveguide antenna apparatuses are provided so that respective short-circuited one ends of the rectangular waveguides of said waveguide antenna apparatuses are opposed to each other.

31. The array antenna apparatus as claimed in claim 29, further
25 comprising diversity selection means for selecting and outputting a received signal having a larger signal intensity out of two received signals

received respectively by said two waveguide antenna apparatuses.

32. The array antenna apparatus as claimed in claim 30, further comprising diversity selection means for selecting and outputting a received signal having a larger signal intensity out of two received signals
5 received respectively by said two waveguide antenna apparatuses.